proportion of cases decided congestion, tumefaction, and even inflammation have been noted after death.

It appears to us, then, that phosphorus acts as so many other poisons do, by entering the blood in the form of a highly irritant substance, and in the course of its excretion from the various glands, induces a degree of irritation bordering on inflammation, attended with a proliferation of cells, which, as frequently happens, are not fully organized, and readily undergo fatty degeneration.

There is, however, one further point in the action of phosphoric acid which must strongly favour the occurrence of this change, and which, indeed, has been assigned by Munk and Leyden as the sole cause of it—I refer to its action on the red blood-globules, which, as shown by these observers, are dissolved by it as by the bile acids. The falling of the temperature of the blood, the ecchymoses of the serous membranes, the serous effusions stained with dissolved hematine, the bloody urine, which are noted after its introduction, are all results of the same peculiar action.

The manner in which this destruction of the red globules, which are the oxygen-carriers of the blood, favours fatty degeneration, is evident; and, when combined with the tendency which always exists in cells formed by unduly active proliferation, to undergo this change, appears to me to afford a satisfactory solution of the extraordinary lesions met with in phosphorus poisoning.

I may add that the authors just referred to have extended their experiments to sulphuric, nitric, oxalic, and tartaric acids, and have shown that all substances which dissolve or destroy the blood globules tend to produce fatty degeneration of the various tissues.

It may not, in conclusion, be amiss to again allude to the strangely close similarity between the symptoms of yellow fever and acute atrophy of liver, and those of poisoning by phosphoric acid, taken in connection with the fact that the bile acids resemble it closely in their action on the blood.

ART. V.—*Sources of Error in the Analysis of Urine.* By M. C. LEA and WALTER F. ATLEE, M. D.

OUR attention has been recently attracted to two sources of error in urine analysis. As these are such as may very easily take place, and may lead to very serious errors in treatment, it has seemed desirable to call attention to them. The one source of error leads to an *under-estimation of the quantity of uric acid*, the other to an *illusory detection of fat.* In this last the illusion may be such as to deceive inexperienced observers, and lead to the supposition that fatty matter is present in large quantity, when there exists in reality not a trace of it.

1. *Under-Estimation of Uric Acid.*

When urine has been freed from any possible presence of albumen by boiling and filtration, whilst the heat keeps the alkaline and earthy urates in perfect solution, it is usual to add nitric acid to decompose the urate of soda, and of ammonia and lime, if these last be present. In the older treatises it is directed to evaporate gently to the consistence of a syrup and then, after standing, the crystallized uric acid is caught on a weighed filter, well washed, dried, and weighed.

In the later treatises this evaporation is rejected as unnecessary; because it is affirmed that uric acid is nearly insoluble in the acidulated urine, so that the quantity thus lost is unimportant, or at least is compensated for by the colouring matter which attaches itself to the uric acid, and increases its weight. Thudichum gives approvingly the following statement:—

"It has been estimated by Heintz that the loss incurred by the imperfect insolubility in acidulated urine of uric acid amounts to 9 parts in 100,000 of the urine used for the analysis, and that this loss is not increased by the presence of sugar, albumen, or the soluble constituents of the blood. In all cases this loss is compensated by a certain amount of red or brownish colouring matter, which is mechanically but intimately adherent to the particles composing the crystals." (p. 84.)

A reduction of the urine by evaporation Thudichum considers only necessary when it contains bile, and then because the uric acid may contain so much colouring matter that its weight may be over-estimated.

The amount of colouring matter usually attached to the crystals he estimates at one-tenth, which may be balanced against the amount retained by urine.

As respects the time needed for the uric acid to crystallize out, the information given is very vague. "The crystallization of uric acid may be said to be completed when all the crystals are of nearly uniform size. But as we possess no other indication on this point, the acidulated fluid must be allowed to stand rather longer to make sure of a perfect precipitation." (p. 84.) This information is, to the last degree, indefinite. There are no crystallizations of *any* substance the crystals of which are of uniform size. In another place (p. 83), *twenty-four to forty-eight hours* are spoken of.

To ascertain whether a correct result could be obtained in this way, several analyses were made; and, after determining the quantity of uric acid obtained, the residues were worked over, and the quantity of uric acid not obtainable by the above process was determined. The results were such as to show that this method is to be adopted with a good deal of hesitation, and is never to be depended upon except after the operator has, by repeatedly checking analyses of this sort by a second analysis of the residues, learned exactly how far he can trust his results. The above directions may be strictly followed, as will presently be seen, and yet one-third of the uric acid may be lost. We would recommend always to let the acidified urine remain three full days, at least, to allow of a full deposition.

Analysis 1. After acidifying the urine (45 oz.) it was allowed to stand forty hours. The uric acid was caught on a weighed filter, washed and dried, and weighed . . . . 7.55 grs.
The filtrate was then evaporated to a syrupy consistence, much nitrate of urea crystallizing out, the uric acid was caught on a weighed filter, well washed and dried, and weighed . . 5.60 "

Analysis 2. Another specimen was treated in the same manner, but allowed to stand sixty hours. Uric acid found . . . 7.45 grs.
The filtrate yielded only . . . . 0.85 "

Analysis 3. Another specimen treated in the same manner yielded, after seventy-two hours . . . . 10.95 grs.
The filtrate was found to contain . . . . . . 0.65 "

It will thus be seen that the relative proportion of loss decreases steadily with the length of interval allowed. But the proportion of uric acid *not* obtained in the first determination is larger than these figures indicate. For it is to be remembered that uric acid is not entirely insoluble in water, and that in the above method of operating the uric acid is divided into two portions, which are separately washed. This washing must be thorough, in order to get rid of the nitrate of urea; and as the tendency of the uric acid is to choke the pores of the paper, the filtration is very slow; consequently, the uric acid is exposed for a long time to the solvent action of the washing water. The loss is doubled by the separation into two operations.

It will, therefore, always be better to largely evaporate the acidified urine—a reduction to one-fourth or one-fifth would be proper; this should go on very slowly, upon a sand-bath, and should occupy three, four, or five days. If it is necessary to make an analysis without the convenience of a sand-bath, the urine (which should, of course, represent the entire secretion of twenty-four hours, or better, of forty-eight) should be acidulated with nitric acid, using about one ounce to fifty, and should then stand about four days.

If the reduction by evaporation has been included, and has been carried so far as to produce crystallization, particular care will be necessary to free the uric acid from adhering nitrate of urea. This latter substance will crystallize around the uric acid in such a manner as to adhere with the greatest pertinacity, and, without particular attention, may give rise to great exaggeration of the quantity of the acid. It will be best to stop the evaporation as soon as crystalline crusts begin to form; or, if a considerable crystallization have taken place, pour off the liquid portions into the weighed filter, and then add cold water to the crystalline portion, let stand for five or six hours, then pour off upon the filter, and repeat this half a dozen times. To affect a complete solution, a removal of the nitrate of urea upon the filter itself would require too large a quantity of water and corresponding loss of uric acid.

2. *Illusory Detection of Fat.*

When fatty matters are existing in a state of emulsion in the urine, it is usual for either qualitative or quantitative determination to agitate a portion of the urine (an ounce is a convenient quantity for qualitative observation) thoroughly with about its own bulk of ether; the fat dissolves in the ether, and may be separated by a pipette or separating funnel, and by spontaneous evaporation leaves the fatty matter behind.

In examining a specimen of urine in this way, the ether, after agitation, rose to the top so charged with matter as to resemble a half liquid pomade. It was perfectly white, and so thick as to be pasty. On inclining the bottle, it would only slowly follow the motion, and stop before recovering its equilibrium, so that one side stood higher than the other. It adhered to the side of the glass vial in smeary greasy drops. If violently shaken up, it retained a quantity of bubbles, acquiring a lathery appearance; these would remain for days, but finally disappear, leaving the semifluid, opaque white matter as before.

Separated by a pipette, and spontaneously evaporated, it left a dirty, whitish greasy mass.

An illusion so complete as this is very rarely seen. The appearances were calculated to leave no doubt of the presence of quantities of fat, which were apparently obtainable in the solid state by the evaporation of the ether. Nevertheless, a careful examination of this residue showed that, instead of consisting of fatty acids, it contained nothing but the normal constituents of urine—viz., urea, urate of soda, colouring matter, &c.; in a word, this apparently fatty matter was *soluble in water*, and when dissolved reconstituted normal urine.

This conclusion received a confirmation in the fact that the residual urine, after treatment with the ether, was capable of producing a similar result with a fresh portion of ether, though less easily than at first.

As no appearances of this sort seem ever to have been described, it was thought desirable to endeavour to fix the conditions under which this remarkable emulsification (for such it undoubtedly is) takes place.

It was found that different specimens of urine, even from the same person, varied a good deal in their capacity for emulsifying.

It was desirable that the experiment should include at least one specimen ascertained to be perfectly healthy and normal. Such a specimen was obtained, and its character verified. When this was tried, two different specimens of ether were used for comparison. With one of these the emulsion was immediately obtained; with the other, nothing of the sort was apparent, even after prolonged agitation.

This difference is interesting, and it is believed depends upon the different proportions of *alcohol* contained in the ether. A large proportion of the ether now manufactured is intended for photographic purposes; in such, the presence of water is extremely injurious, but of alcohol comparatively unimportant. This explanation was confirmed by the fact that the addition of a few drops of alcohol to the specimen of ether that refused to emulsify, immediately conferred on it that property.

Too much importance, however, is not to be attached to the function of alcohol; for a few hours' standing conferred on the normal urine the property of emulsifying with the specimen of ether which before it had not possessed, and another specimen of urine possessed from the first the property of emulsifying with the same ether which the other only emulsified with after standing.

A distinct proof that the fatty-looking, pasty substance is simply an emulsion lies in the fact that, by long standing, a layer of clear mobile ether slowly forms on the top of it. This is, of course, decisive upon the point. If the pasty substance were a solution of fat in ether, no portion of the ether could separate from it by any standing, however prolonged.

The time required for the separation of a stratum of ether is extremely variable. In some cases it takes place in a few hours; in others, not for several weeks. In one specimen, that has now stood for five or six weeks, there is but a thin layer of ether, whilst the stratum of fatty-looking emulsion is over half an inch thick; and even at this lapse of time resembles a semifluid pomade.

It appears, then, that almost any specimen of urine will form an emulsion when violently agitated for some time with ether, especially if the ether contain a small quantity of alcohol; but that this condition is by no means essential; also that different specimens of urine vary extremely in the time of agitation required, in the quality of the ether capable of emulsifying them, and in the time during which the emulsion continues to exist. There exists, however, no doubt that the range of conditions under which this delusive appearance may be produced is very wide, and has, probably, led to many errors in diagnosis.

When, therefore, ether appears to dissolve out fatty matter from any specimen under examination its physical condition must never be taken as evidence. It must be separated, allowed to evaporate spontaneously in a beaker or basin, and the solid residue must be examined. Solubility of the residue in water will at once indicate that fat is not present.

Philadelphia, February, 1869.